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Original Article/Research

Public acceptance of biofuels in the transport sector in Finland

Md. Munjur E. Moula [a,*], Judit Nyári [b], Angela Bartel [b]

[a] Department of Social Research, Faculty of Social Sciences, University of Helsinki, Finland
[b] Department of Mechanical Engineering, School of Engineering, Aalto University, Finland

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Abstract

The Finnish transportation sector is the second biggest greenhouse gas emitting sector in Finland. Despite large-scale investment and government commitments to promote biofuels for transport sectors in Finland, little is known about the public acceptance of this alternative transport fuels. Public's opinion, awareness and knowledge can contribute to social acceptance of new renewable energy and to the overall improvement of consumers' energy behaviour. This study examines public acceptance in terms of public's opinion and knowledge about biofuels and their consumer patterns of transportation fuels by designing a multiple-choice questionnaire with four groups of questions: background information, community perspective, social perspective, and market perspective. The analysis of 90 respondents' survey shows that 50% of the respondents think that there is a direct effect of biofuel production on food prices and would not buy biofuels derived from food crops. Only 60% of them are willing to switch towards purchasing biofuels; however, the lack of information about biofuels prevents them to use biofuels for their transports. Finally, 63 respondents of the car owners, their ideal fuel would be hydrogen (20%), electricity (60%), and other (20%), which meant hybrid. Study findings have important policy implications related to the public acceptance of biofuels in the transport sector.

Keywords: Public acceptance; Biofuels; Consumption behaviour

1. Introduction

The European Union is devoted to increase the share of renewable sources in its energy portfolio (Galanopoulos et al., 2017). By 2020 the target for renewable sources in fuels used in the transportation sector is 10% for each member state (European Commission, 2015). In 2010, the average share in the member states was around 4.7%; Slovakia and Sweden being the closest to the target by having 8% renewable share within transportation fuels.

Finland as a member state of EU aims to reduce around 4 million tonnes of CO_2 by 2020, partially by increasing the share of renewable energy sources in the transportation sector (Finnish Petroleum and Biofuels Association, 2016). The transportation sector of Finland accounted for 11.1 million tonnes of carbon dioxide equivalents in 2014 (Statistics Finland, 2016). This corresponds to a share of almost 19% of total greenhouse gas emissions in 2014. The transportation sector is not only linked to daily human activities and economic growth, but also it is extremely

* Corresponding author.
E-mail addresses: munjur.sa@gmail.com, munjur.moula@helsinki.fi (Md. Munjur E. Moula), judit.nyari@aalto.fi (J. Nyári), bartel.angela@aalto.fi (A. Bartel).
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dependent on fossil fuels. Transportation being the second biggest greenhouse gas emitting sector in Finland, the actions need to be taken so that the country's long term targets can be reached. In fact, Finland as a developed country, this dramatic increase has also raised both environmental and social concerns (Mattioli, 2016).

1.1. Public acceptance of biofuels (Finland)

As a fact, all transport fuels which are distributed in Finland already contain -to a certain amount- bio components. The limiting values for blending of bio components are set based on quality criteria standards. The aim to increase the share of renewable energy sources in the transportation sector can not only be hindered by a technological and/or economic barrier, but also by a social barrier. Social acceptance has often been underestimated when developing new technologies (Moula et al., 2013). Of importance is also public's awareness and knowledge as it can contribute to social acceptance of new technologies and to the overall improvement of consumers' energy behaviour (Karytsas and Theodoropoulou, 2014). Very few numbers of the studies (Electra et al., 2010; Balogh et al., 2015; Moula et al., 2013; Cross Border Bioenergy, 2012; Zhang et al., 2011) conducted in public acceptance of renewables area which require more work to clarify public acceptance of biofuels and consumption patterns of transportation fuels.

Therefore, from a social, community and market perspective point of view, the intentions of this study are to assess the public awareness and knowledge about biofuels and their consumer patterns of transportation fuels in Finland. The aim of this study is to have an overview of what the potential customers of biofuels think about its sustainability and what would motivate them to change their consumer behaviour in favor of biofuels. Those results can help to find a new door to measure energy policy related to the public acceptance of biofuels for transportation.

2. Theoretical discussions

As mentioned earlier, very little information about public acceptance in terms of public awareness and knowledge of biofuels and their consumer patterns of transportation fuels in Finland can be found in the literature. However, following sections will provide treasure trove knowledge on how public acceptance of biofuels and consumption patterns of transportation fuels is being evaluated in the existing literature.

According to Balogh et al. (2015) who studied several surveys about consumers' knowledge concerning biofuels reported that consumers have little knowledge about the field and are rather under-informed. Their study was conducted amongst car users who follow the automotive industry related news therefore were assumed to be better informed about the topic of biofuels than the average. Their study of 386 respondents showed rather high awareness of biofuels, moreover more than half of the respondents have already tried biofuel before. Majority of the respondents, 206 people, mainly those who had knowledge and experience regarding biofuels, was clearly supporting biofuels which showed by agreeing with positive and refusing negative statements. The report concluded that Hungarian drivers have positive attitude towards biofuels, however, it is recommended to further increase the available credible information about the topic.

A case study about energy technologies and regarding social sustainability and social acceptance by Assefa and Frostell (2007) discusses the importance of assessing social indicators when implementing new technical systems. Social indicators refer different factors of public acceptance and give a critical summary of existing social research on the acceptance of renewable energy technologies, e.g., biotechnology. Public acceptance of biofuels study (Electra et al., 2010) shows that in Greece, a very few people prefer to use biofuels in their transportation compared with other renewable energy sources. This is just because of significant lack of information about biofuels. Hence, the authors argue that the degree of social acceptability of biofuels in transport sector has not yet been well established.

Zhang et al. (2011) investigated Chinese consumers' awareness and attitude towards biofuels in Nanjing. They interviewed 374 private vehicle drivers. The report concluded that 90% of the respondents need further information about biofuels. There was a significant difference between passenger vehicle drivers and freight vehicle drivers. The drivers in the two groups showed difference in the relative importance of fuel-related factors and policies. The biofuels study by Giraldo et al. (2010) shows that the diesel car owners' willingness to pay for biodiesel, but the biggest disagreement between the car owners' regarding advantages and disadvantages of biodiesel was about its direct effect on food prices (Tyner, 2013). Authors also mentioned that other important fact preventing them from buying biodiesel was its lack of availability at the closest petrol station. In this situation, biofuels have ignited many debates regarding their environmental, social and economic impacts (Fernando et al., 2017). Issues such as change of land use and food versus fuel have emerged as a strong barrier for biofuel development (Lane, 2015; Chin et al., 2014).

Cross Border Bioenergy (2012) published a *Biofuels Market Handbook* in 2012 which evaluates bioenergy markets in the EU. 50 measurement criteria were considered for their market research, including public support/acceptance. Finland was placed on an average rank of 43 out of total 81 regions for public acceptance/knowledge of technology for the biodiesel as well as bioethanol sector. It is important to note that biofuels belong to the more

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general field of biotechnology. Unfortunately, 'Finnish people are not well informed about biotechnology' (Tilman et al., 2009). Therefore, further information is needed to know how the criterion was measured for knowing public acceptance biotechnologies in Finland.

From a more general point of view, the article by Moula et al. (2013) shows how social acceptability in terms of public acceptance of renewable energy technologies in Finland is being conceptualized. Additionally, this study shows that how stakeholders may influence the development of community renewable energy and underlines 'the importance of identifying stakeholder groups since they might have a positive or negative influence on projects' (Hai et al., 2015; Ruggiero et al., 2014). In these lines of thought we can say that public acceptance plays 'an important role and sometimes even serves as the key indicators for a bioenergy product's success in the marketplace' (Radics et al., 2016).

3. Methodology

This section describes the design of the survey questionnaire (see, Appendix 1) followed by the selection method used for sample respondents and data collection. Finally, it defines how the collected data was analyzed.

3.1. Sample and data collection method

For this study, a total number of 90 people (40% female and 60% male) participated to the survey. The respondents recruited for the investigation come from randomly different age groups. However, study respondents were divided into three groups. For example, 30 people fell into 17–25 age group, 49 people from 26 to 40 age group and 11 people belongs to the age group of 41–64. These age groups were chosen specifically to understand the role of age condition on acceptance of biofuels. Majority of the respondents were employed (64%), whereas the second largest group of respondents were students (30.3%), and few of participants were unemployed (5.7%). In addition to this, 35% of the total respondents have a Bachelor degree as highest education level, while 26% participants have a High School degree, and 21% of the respondents have a Master degree (see more in Fig. 1). We conducted this survey in the capital region (Helsinki, Espoo and Vantaa) of Finland. The selected areas are more multicultural than other cities in Finland. Besides, the selection of these three cities forms also a more cost- and time effective way to conduct this survey (Moula et al., 2015a). The survey represents 25% of respondents from Espoo city, 27% from Espoo city while the remaining 48% of them from the city of Helsinki. The field survey activities were carried out from April to June 2016, on different days and at different hours of the day.

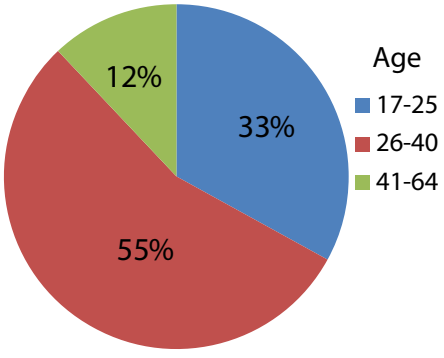

Fig. 1. Age group of the respondents.

While conducting the survey several respondents were worried that they would say the wrong answer as they did not have enough information about the topic, especially those who do not own a car. They were informed that most of the questions do not have a correct answer, and the questionnaire is focused on whether they are familiar with the topic or whether they lack some information regarding it.

3.2. Questionnaire

For this study, our survey questionnaire consisted of 16 structured questions without the three ones in the *Background Information* section (see, Appendix 1). The questionnaire was designed in a manner that there were no correct or incorrect answers, the difference between the answers are only dependent on personal viewpoint and experience. The goal of the open-ended survey questionnaire was to assess the public's opinion and knowledge about the use of biofuels in transportation and food-crops used for biofuel production. It was also intended to determine their motivation to a possible shift towards biofuels and their fuel consumption patterns. Before starting the fieldwork, the scope and content of the questionnaire were discussed with research team. As earlier mentioned, three perspectives (social, community and market) shall be considered when implementing innovations or a new product innovation process. The study questionnaire schedule for the survey participants has been prepared to include four parts, which covered various issues that can be seen from the following sections.

The purpose of part one was to gather background information about the interviewee such as, age, educational level and gender. This was to make sure to collect information from a variety of people (e.g., not just interview males, but females too). A deeper analysis could have been driven with this first section along with the results of the remaining sections but the number of participants (n) would have to be higher in order to have consistent results (e.g. $n = 100$). Part two, social perspective, was attempted to measure the respondents' knowledge about the European Union's targets regarding biofuels, and to survey what

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would motivate them to choose biofuels. Part three, community perspective, was intended to study the respondents' opinion about the importance of environmental issues. The section also investigates how the respondents personally judge biomass and bioenergy with respect to being renewable and greenhouse gas emission free. Finally, part four, the market perspective, was designed to investigate each respondent's fuel consumption pattern; and their current and future vehicle choice with regards to its type of fuel consumption (de Gorter et al., 2013) Other important question was whether they think there is a connection between the production of biofuels and increasing food prices.

3.3. Data analysis

We collected the survey results from all the group members by filling out questionnaire data in tables. After that, we started conducting the quantitative analysis by summarizing all the data and calculating the percentage of the choices for each question. Besides, in this study content analysis was also used to determine the presence of certain concepts, topics and, 'identifying unique themes within texts or sets of texts' (Moula, 2014; Moula and Törrönen, 2016). The content analysis provided us an avenue to understand the social reality in terms of public acceptance of renewable energy technologies in a subjective but scientific manner (Jung et al., 2016; Moula and Törrönen, 2016). Also correlations were investigated between several questions as to identify certain patterns and beliefs regarding biofuels. In the following paragraphs, we have discussed about how we arranged collected survey data for this study.

4. Results and discussions

4.1. Background information

In this study, 3 questions (in part one) were addressed to know the background information of all the interviewees including age group, level of education and gender of the interviewees as mentioned earlier. The ratio of the interviewees for the age and education related information is shown in Fig. 1 and Fig. 2 respectively.

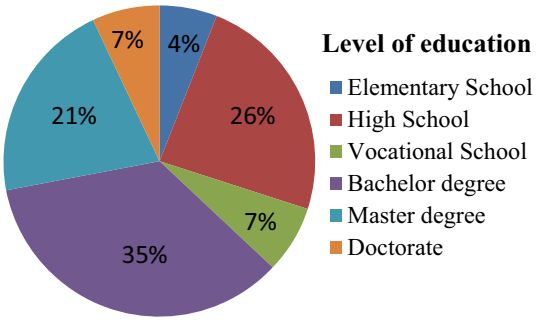

Fig. 2. Education level of the respondents.

Fig. 2 indicates that the majority respondents (70%) were educated. Thus, the responses were weighted so that the results were more representative of the state's population.

4.2. Social perspective

As Balogh et al. (2015) observed in the analyzed survey studies further education of consumers is obligatory. This result also agrees with the findings of Giraldo et al. (2010) where the respondents required further information to be convinced about buying biodiesel. This study shows that only 10% of the respondents have heard about the EU's policy regarding the compulsory 10% share of renewable sources in fuels used in the transportation sector. 30% of the respondents also agreed that they would like further information regarding biofuels to be motivated to shift towards changing to biofuel consumption.

Table 3 shows how the respondents think about their personal motivation and what the governments should do to convince consumers to change to biofuels. As it can be seen 60% study respondents think that the best solution from the governments' side would be to lower the price of biofuels. 27 respondents also personally thought that lower prices would convince them to change to biofuels. Personal motivation was in most of the cases the availability of biofuels. In the study of Giraldo et al. (2010) the main reason for not buying biodiesel was that it was not available at the closest petrol station. In this study, it also shows that respondents would consider changing to biofuels if it was available in a wider range of petrol stations (see, Chatterton et al., 2016).

Regarding price sensitivity 60% respondents are willing to pay at least 5% more for biofuels as compared to traditional transportation fuels. Those whose personal motivation for switching to biofuel consumption was lower price mostly said that they would not pay more at all for biofuels. However, even paying 20% more for biofuels is significantly less considering that biofuels usually cost 50–200% more compared to gasoline (Lund, 2015). Comparing the results with the study by Giraldo et al. (2010) where the average premium for biodiesel was 5%. It can be argued that the respondents in this study are willing to pay more than that. On average the premium price is 7% more compared to price of conventional transportation fuels. The discussion on biofuel price matter has directly linked to public acceptance in terms of people's consumption behaviour (Fouquet, 2016) in their transportation.

4.3. Community perspective

All the respondents are environmentally conscious, which corresponds to the findings of Balogh et al. (2015) that Western societies have increased environmental awareness. Most of them are concerned about global warming and overpopulation, while waste disposal is ranked as second. During the interviews 90% respondents mentioned

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Table 1
Correlation between biofuels being renewable and their GHG emission.

Do you think that fuels derived from biomass should be considered renewable?	Do you agree that biomass does not contribute to greenhouse gas emissions?	
	Yes	No
Yes	36	18
No	18	18

Table 2
Correlation between direct influence of biofuels on food prices and willingness to buy biofuel derived from food-crops.

Do you think that the production of biofuels has a direct effect on food prices?	Would you decide not to buy certain biofuels if you knew those are derived from food crops?	
	Yes	No
Yes	45	18
No	0	27

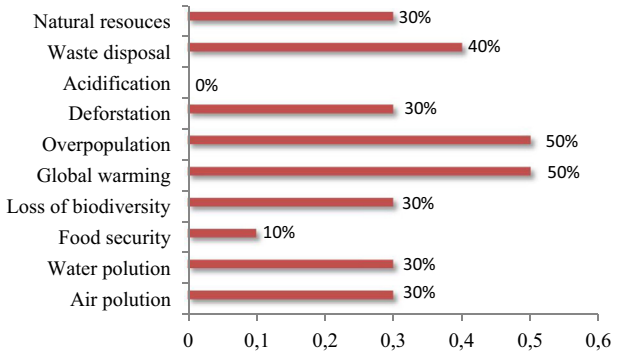

Fig. 3. Most serious environmental issues according to the respondents.

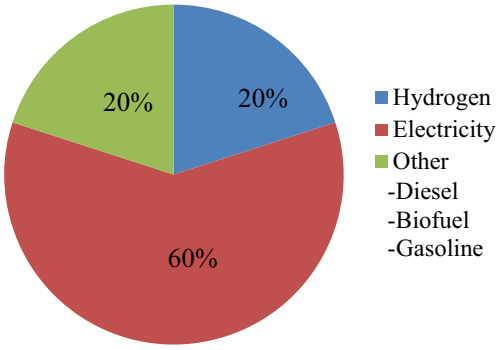

Fig. 4. The most ideal fuel according to the respondents.

that solving the problem of overpopulation would benefit all the other environmental issues (see, Fig. 3). At the same time only 10% respondent found food security an urgent issue, but this might relate to the fact that the interviews were made in Helsinki, Espoo and Vantaa, Finland where food supply is efficient and shortages are uncommon.

Only 20% of the respondents stated that biofuels are not renewable while they also believe that biofuels do not emit greenhouse gases (GHG). One of these respondents also claims that there is nothing that would motivate her to change to biofuels; however, further information from the government would be appreciated. According to 37% respondents, biofuels are renewable, but they do emit GHG. Other 3% respondents said that biofuels are not renewable, and they do emit GHG. The rest, 40% of the study respondents said that biofuels are both renewable and do not emit GHG. It is important to mention here that only 5 respondents commented that it is a perspective of time; on what time scale one is examining the emissions (see Table 1).

Table 2 reflects the relation between how respondents think about production of biofuels relating to food prices and their own willingness to buy biofuels derived from food-crops. All together 70% of the respondents stated that there is a direct influence on food prices due to the increased demand and support for biofuels. In the study

Table 3
Correlation between personal and governmental motivation.

What would motivate you to change to transportation biofuels?	How do you think the EU governments should motivate customers to choose biofuels over traditional gasoline/ diesel?	Number of respondents
Availability	Lowering prices	27
	Providing further information	9
	Nothing	9
Price	Lowering prices	27
	Providing further information	9
	Nothing	0
Nothing	Lowering prices	0
	Providing further information	9
	Nothing	0

EU policies besides motivation to switch to biofuels were also considered in the survey. The respondents were asked whether biofuels from food-crops should be treated under EU law as biofuels derived from non-food crops. 70% of the respondents agreed that both types of biofuels should be treated under EU laws.

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of Giraldo et al. (2010) the direct effect of biodiesel on food prices was the issue where most of the respondents did not agree. However, in this study most of the respondents agreed that there is an existing relationship between biofuels and food prices. According to 30% of the respondents, there is no relation and would buy biofuels based on food-crops. 50% respondents who said that food security is a major environmental issue supports (see more, Ruepert et al., 2016) their belief throughout the questionnaire as they would not buy fuel based on food-crops, and believes that there is a direct link between food prices and biofuel production and they also do not support food-crops being grown specifically meant for biofuel production.

In this study we also found that only 20% respondents believe that that food-crops should be grown specifically for biofuel production, however, one of them sees a relation between food prices and biofuels and would not buy biofuels derived from food-crops.

4.4. Market perspective

In this study, 63 respondents (70%) own car currently, which consume diesel, gasoline or other, which meant hybrid. None of the currently owned cars consumed hydrogen, or only electricity. However, when it was asked what the most ideal fuel would be 60% answered electricity, 20% hydrogen, and rest of the 20% other, which meant hybrid for them (see Fig. 4).

According to the survey none of the respondents view biofuels as the most ideal fuel. However, several of them also commented that the ideal fuel let it be electricity or hydrogen is currently not available in a form they would wish it would be. Those technologies should be further developed for them to purchase a car that consumes such a fuel. Those who do not own a car, 30% of the respondents (27), either chose electric car or hybrid car as the most ideal car.

Despite the fact that none of the respondents chose biofuel as the most ideal fuel for their vehicle, the chosen options – electricity, hybrid and hydrogen – can be in fact sustainable and better options compared to conventional fuels. It also means that the respondents are familiar with the consequences of conventional fuels and would rather choose a renewable option in the future.

5. Conclusion

In this study, the public's awareness and knowledge about biofuels, and their consumer pattern regarding transportation fuels was assessed in the capital region (Helsinki, Espoo and Vantaa) of Finland. It can be said that all the respondents had environmental awareness and were willing to choose renewable fuels for their vehicles in the future. However, the consumption of biofuels was rather low. This is just because of a significant percentage (60%) of the respondents were lacking information about them and would require further knowledge to shift towards purchasing biofuels.

Regarding food-crops specifically meant for biofuel production the respondents belief was that biofuel should not be used, as they would result in increased food prices. In this study, 50% study respondents would not buy biofuels based on food-crops since it contributes to greenhouse gas emissions. In this study, 50% respondents lack the availability of biofuels at petrol stations, which if provided might have led to the purchase of biofuel. Another important aspect in shifting towards biofuels was their price. A significant decrease in price would be appreciated, and the 60% respondents would like see governments leading steps in this direction. Thus, we argue that people are really concerned about government being a credible and powerful institution about biofuels for transportation.

Findings from this study show that on average the respondents were willing to pay more for biofuels as compared to conventional fuels. This information could be useful for the development of practice oriented solution strategies. Considering the general wisdom in terms of people's level of acceptance, public sector should take the first step towards the overall improvement of consumers' energy behaviour towards the use of biofuels (Schmidt and Weigt, 2016), which would make them carry also part of the responsibility to inform people and provide sufficient information since a significant lack of information is stopping the prospective of biofuels and current car owners from buying them. Hence, there is no doubt that a significant lack of information about biofuels for transportation especially when communicated to the people in general (Radics et al., 2016).

Finally, it is our hope that there is a will to change to renewable fuels, such as hydrogen and electricity. If the technological barriers and availability issues could be solved there is a prospect of significant change from conventional fuels to renewable ones in the future. This can help to meet the very important subject of national or even European energy policy target.

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Appendix

Questionnaire

Background information about the respondent

Age group

a) below 18 b) 18 – 24
c) 25 – 34 d) 35 – 44
e) 45 – 54 f) 55 – 64
g) above 64

Educational level

a) elementary school b) high school
c) vocational school d) Bachelor degree
e) Master degree f) Doctorate

Gender

a) female b) male

Social perspective

1) Have you heard that the European Union would like 10% of transport fuels in each EU country originate from renewable sources such as biofuels?
   a) yes b) no
2) Do you think that biofuels derived from food crops should be treated under EU law as biofuels from non-food crops such as forest waste?
   a) yes b) no
3) What would motivate you to change to transportation biofuels?
   a) price b) availability
   c) reliability d) nothing
4) How do you think the EU governments should motivate customers to choose biofuels over traditional gasoline/diesel?
   a) by lowering the price of biofuels (through subsidies or lower taxes)
   b) by providing further public information about biofuels
   c) the governments should not do anything
5) Do you think that the production of biofuels has a direct effect on food prices?
   a) yes b) no

Community perspective

1) Are you worried about environmental issues?
   a) yes b) no
2) If yes, what is/are the most serious environmental issue/s in your opinion? (up to 3 answers)
   a) air pollution b) water pollution
   c) food security d) loss of biodiversity
   e) global warming f) overpopulation
   g) deforestation h) acidification
   i) waste disposal j) natural resource depletion
3) Do you think that fuels derived from biomass should be considered renewable?
   a) yes b) no
4) Do you agree that biomass does not contribute to greenhouse gas emissions?
   a) yes b) no
5) In your opinion, should food-crops be used specifically for biofuel/bioenergy?
   a) yes b) no

Market perspective

1) Do you have a car?
   a) yes b) no
2) What kind of fuel does your car consume (skip the question if you answered *no* to the earlier question)?
   a) gasoline b) diesel
   c) electricity d) hydrogen
   d) other
3) Would you decide not to buy certain biofuels if you knew those are derived from food crops?
   a) yes b) no
4) How much more would you pay for biofuels compared to traditional gasoline/diesel?
   a) max 5% more b) max 10% more
   c) max 20% more d) more than 20% extra
   e) would not pay more
5) Does the fuel type the vehicle consumes have an effect on your vehicle choice when considering buying a new one?
   a) yes b) no
6) What would be the most ideal kind of fuel in your opinion?
   a) gasoline b) diesel
   c) electricity d) hydrogen
   e) biofuel f) other

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